HUMAN FACTORS IN SHIP DISMANTLING – A SAFETY APPROACH: REALITY VS BEST PRACTICE

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ABSTRACT

Ship dismantling (SD) is often considered as reverse ship building. For many years, ship dismantling has been neglected by the shipping industry due to lack of rules and understanding, hence severe consequences affecting both nature and human life have occurred. There has been growing concern about the health and environmental impacts of ship dismantling [1]. Therefore the impact of ship dismantling has been severely criticized by governmental and international shipping authorities as well as non-governmental organizations (NGO). As a result the procedure of developing new rules and regulations has been triggered and the safety culture is being questioned in the ship dismantling business. Although most countries that are in the ship dismantling business have almost no regulations related to ship dismantling, the case investigated in this article is Turkey, and the situation in Turkey is very different than the other major ship dismantling countries. The main reason for this difference is of course Turkey's governmental laws and regulations on environmental protection and safety at work, as well as Turkey's negotiations with the EU parliament. Current rules and practice on safety in shipping have been discussed in this paper. This article is the combined work of the University of Strathclyde, the Ship Recycling Association of Turkey and Ege Celik Ship Dismantling Yard in Turkey, with the aim to compare a successful business with the available best practice in ship building in the UK.
Keywords: Human factors, Ship dismantling, Health & Safety

1. INTRODUCTION

After completing their operational life, ships go to their final destinations: ship dismantling yards. Ship recycling is a valuable business, which creates value for the ship owner's obsolete vessel as well as the ship dismantler who tries to make a profit by recycling the vessel. Most importantly, it re-utilises the resources on earth. However the impact of this business on humans and the environment has been of increasing concern internationally. Therefore the IMO (International Maritime Organisation) organised Ship Recycling Convention. If a recycling facility doesn't fulfil the IMO requirements, it wouldn't be allowed to receive a party ship unless it has taken further actions to comply and being authorized by its competent authority [2]

Although ship dismantling countries are located thousands of kilometres away from each other, many similarities can be found in ship dismantling procedures, and the reason for these similarities is due to the intention of the ship dismantling yards to make the business as simple as possible in order to make more profit. However there are differences in the application and these differences are caused by the dynamics of each country, namely; governmental laws and regulations, international laws, organisation levels, awareness, worker profile etc.

The ship dismantling facilities at Aliaga, Izmir, is the only place in Turkey where ship demolition activities are permitted. This declared ship dismantling area, has a coastal stretch of 1300 metres and there are currently 21 companies in operation. The annual ship recycling capacity of these companies is 900 000 LDT in total. The biggest ship which can be accepted is 50 000 LDT and the maximum work force is 2800 when working full capacity.

The ship dismantling practices in Turkey differ from those applied in the Asian subcontinent. The ships for scrap are neither dismantled in a dock nor beached. The process in Turkey represents one intermediate stage using concrete lined slipways in an area without tides. The ships are pulled ashore and can be treated above ground level with minimised risk of spillages

Being in the negotiations with the EU parliament about joining the EU, Turkish HSE laws have been updated to be in line with EU regulations and companies are forced to comply with these rules. The activities of the companies are conducted in compliance with national laws, regulations, international agreements and guidelines. Turkey can recycle ships without violating the Basel Convention, therefore a proper waste management system is available and used in the shipbreaking facilities.[3] ILO (International Labour Organisation) and IMO guidelines related to ship dismantling activities are also being followed.

Ship dismantling companies in Turkey are represented by the Ship Recyclers' Association of Turkey (SRAT). Although each company is responsible for managing their own HSE issues, SRAT is internally auditing the companies and keeping records and directly reporting to the Turkish Government. Governmental experts are regularly auditing both SRAT and the individual companies.

In this paper the current practice in Turkey is explained and the worker profile is investigated by conducting a survey and a case is investigated in order to present the procedure and safety measures applied. This case is then discussed by various safety experts to identify any gaps in order to enhance the practice towards best practice.

2. FIELD STUDY

A field visit is conducted by the University of Strathclyde, lasting one month, in order to investigate the ship dismantling procedure in Turkey.

2.1 HUMAN ELEMENT

A ship dismantling yard in Turkey is likely to employ between 30 - 100 people [4] and undoubtedly human element is at the core of all ship dismantling procedures. Human workforce in ship dismantling business is both the one who is affected by and the one who affects the ship dismantling procedures hence the good management of human factors is of vital importance. Due to various reasons including cheap workforce, lack of governmental laws as well as limited technology, almost all countries are using manual work force in the majority of ship dismantling procedures and this makes the ship dismantling business more dependent to human element. Although Turkey has a better automation level than other ship dismantling countries, the human element is still the most important factor in ship dismantling both in terms of the quality of the work being done and the economics.

Naturally, whenever the human workforce is involved, accidents and injuries are encountered, although the regularity and number of these accidents and injuries vary significantly depending on the economical conditions of those countries.

The main reasons for a country to be in the ship dismantling business are listed below.
If all three listed below are not suitable, then in that country ship dismantling will probably not be a good business to set up.

- Cheap work force
- Market need for scrap metal and reusable items
- Laws and regulations

It was mentioned by an experienced ship dismantling manager that; when ship dismantling is considered if you move towards the best practice on paper both in terms of HSE, laws and regulations ship dismantling is unfortunately becoming less profitable. Hence dealing with the ship dismantling business requires a high level strategy supported by relevant industries so that sustainable dismantling business can be run.

Managing human element efficiently is the key solution for keeping business safe and profitable. Stranks[5] in his book states that;

"One of the principal objectives of any organization is that of developing and promoting the right safety culture, an aspect which requires a significant human factors input if it is to be successful."

In Turkish ship dismantling yards, by law, all workers are being protected by national insurance, health services as well as pensions while accident records are kept by governmental authorities. Moreover companies are obligated to pay high compensation rates where there are accidents. Figure 1 shows the procedures for accidents at work.

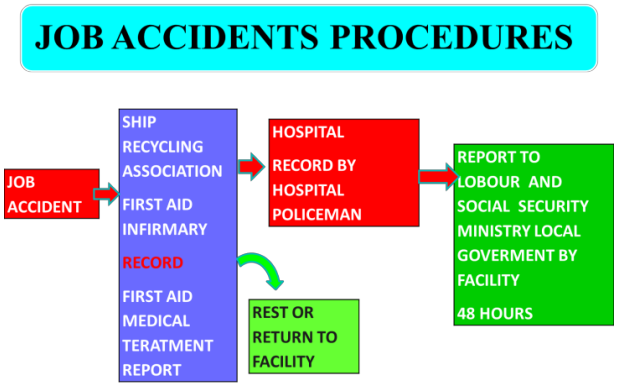

Figure 1: Job accidents procedures

In Aliaga SD yards each company is responsible for their own HSE concerns.

Each SD facility is breaking around 6 ships per year. When a ship is imported to be dismantled in Turkey, the Turkish government requires dismantling yards to finish the dismantling work in a limited period of time.

During the field trip carried out for this study it has been observed that a team of 6-8 workers is necessary for the inventory of hazardous materials (IHM), and even more workers are needed for removing that waste. Therefore removal of waste definitely requires a level of qualification/expertise to be able to perform that job and would cost extra for each company. However instead of each SD yard individually creating their own hazardous material removal department, all ship dismantling yards outsource the IHM and waste removal to the Waste Management Unit which was established under SRAT. Hence the waste management unit is now working as part of SRAT and responsible for all SD facilities waste management with the similar number of workers, but more efficiently, which means less cost for each facility. Moreover with the expertise that they have gained while working in so many ships each year, they even received requests for hazmat removal jobs from land based factories. Similarly SD facilities outsource training and regular health checks to the SRAT as well. Responsibilities of the SRAT are shown in Table 1.

Table 1: Responsibilities of SRAT

Responsibilities of Ship Recyclers' Association of Turkey
Administrative
Following Laws & Regulation
Waste Management
Internal Audit
HSE and In-the-Job Trainings
Periodic Health Screening
Emergency Response preparedness (Oil spill, fire etc)
First aid

In addition, SRAT is appointed by the government as the single contact point which is responsible for management of hazardous material.

2.2 QUESTIONNAIRE

The work being done in the ship dismantling facilities in Aliaga can simply be divided in to three groups. *1) Dismantling 2) Waste Management 3) Health and safety management.* Each group is directly related to human element therefore worker profile will directly affect the quality or success of the work being done.

In order to investigate the human element in Aliaga, during the field trip workers are asked to complete a questionnaire. The aim of this survey was to understand the workers' profile, worker satisfaction, workers' awareness on HSE and trainings they receive, and to ask how frequently workers have been involved in work accidents.

33 workers from different facilities were asked to complete the questionnaire. As the nature of ship dismantling requires working in hard conditions, a very big majority of the workers are males. Therefore, the questionnaire was only for male workers, due to the lack of female workers. Age distribution of the workers taking this questionnaire is shown in Figure 2.

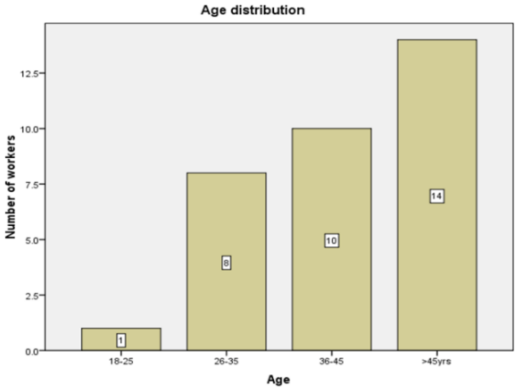

Figure 2: Age distribution

According to the questionnaire results the majority of the workers belong to the group of 45 years and older. (Mean = 42)

Job distribution of the workers who completed the questionnaire is presented in Table 2.

Table 2: Job distribution

Job	Number of workers
Asbestos Removal	7
Chemist	1
Crane Operator	2
Cutter	10
Foreman	6
Maintenance	3
Organiser	1
Ship Cutter	2
Truck Driver	1

According to one site manager (name is not enclosed) experience is very important for a ship dismantling worker. If the work is being done by a human, then the experience of that human will directly affect the job both in terms of safety and productivity. Figure 3 shows the experience levels of the workers in Aliaga.

Figure 3: Worker experience (mean= 19.1, std. dev= 9.6)

The education level of workers is also of great importance because it will directly affect the type of material needed for HSE trainings and signs. It will also affect the depth of training that can be given to these workers. Figure 4 shows the education levels of workers in the ship dismantling yards at Aliaga. According to these results the majority of the workers are primary school graduates therefore all workers are able to read and write. The training which is being given in Aliaga is aimed accordingly to meet that level of educations. Most of the training is given in PowerPoint presentations. Workers are taking small written exams after each training course in order to check how effective the training was.

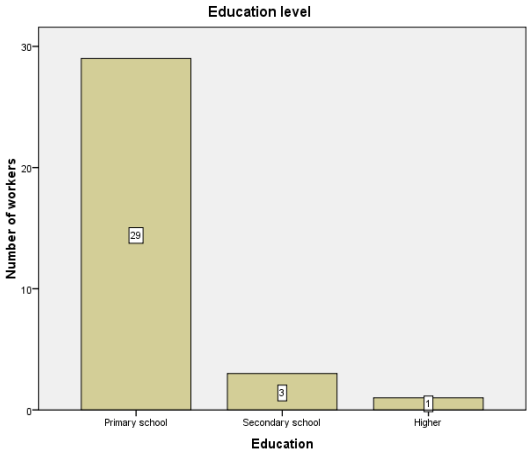

Figure 4: Education level

In the questionnaire there was a group of questions related to training. The results are as shown in Table 3**.** The workers fed back that all training given was related to the job and therefore was beneficial.

Table 3: Training courses that was taken by workers

Training	Yes	No
First aid training	24	9
Health and safety training	18	15
Fire safety training	15	18
Hazmat training	12	21
Training on how to use equipments	18	15
PPE training	28	5

All workers in Aliaga are working 6 days per week with 8 hours shift per day. Workers were asked if they are working overtime or not, 22 responded that rarely, 11 said never. However, they also mentioned that any overtime work is being paid as well.

Many minor accidents have not being reported, such as if worker is cutting a plate sometimes small cuts may occur due to sharp edges. These generally don't require any first aid. The workers were asked how many similar small work accidents they had. Figure 5 shows the response given by the workers.

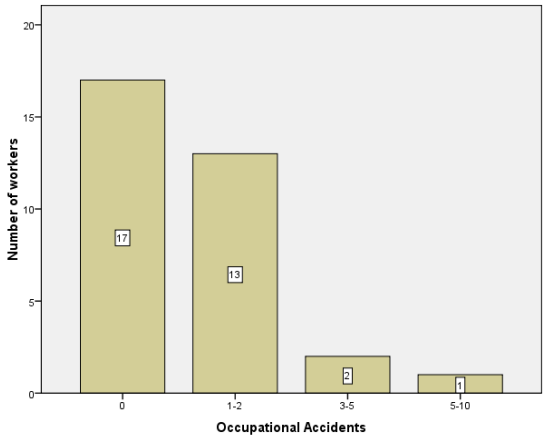

Figure 5: Occupational accidents

Two open ended questions have been asked to the workers, Table 4 shows workers response to the question; "what are the hazardous materials that may be found on board ships?"

Table 4: Workers' hazmat knowledge

Type	Number of workers
Asbestos	32
PCB	3
Gas-oil-fuel	22
Radioactive materials	5
Batteries - accumulators	5
Medical waste	2
Glass wool	3
Chemicals	4

Similarly workers were asked to list the PPE that they are using during their work. The workers' responses are presented in Table 5

Table 5: PPE Usage

Type	Number of workers
Gloves	32
Work wear	14
Helmet	30
Glasses	9
Safety Shoes	27
Mask	18
High visibility jacket	2

Finally, the workers were asked if they are happy to be working in the ship dismantling business and if are they satisfied with the working conditions. Surprisingly all workers answered this question positively.

2.3 DISMANTLING PROCESS

In this section ship dismantling process observed by University of Strathclyde during the Aliaga field study visit, is summarised. The aim of this section is to summarise the current dismantle procedures in Turkey. Observation of block dismantling includes; full block dismantling process which starts with cutting on-board and continues consequently carrying block to shore, carrying to secondary dismantling zone, further cutting in smaller pieces and transport to external site.

The following diagram shows the layout of the dismantling yard, where the current ship due to be dismantled is berthed and the path which the removed L shaped panel section (side/deck of the ship) will follow. Figure 6

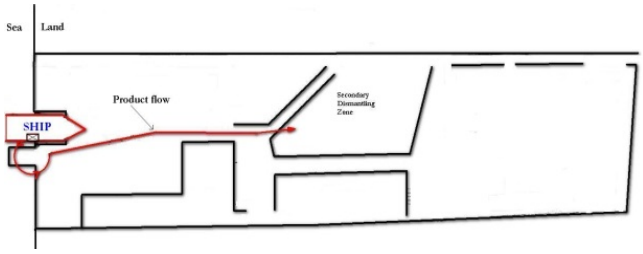

Figure 6: A SD yard lay-out

Observations made during the field study are explained below on a step by step basis in the following subsections.

2.3 (a) Access of Workers on to Ship

There are two ways of workers accessing to the ship; this really depends up on the stage at which the cutting of the ship is at. If the fore section of ship is already cut away and levelled to the ground, the workers can have access to the ship through this point. This is generally the preferred and safest method of access. However, if the ship is at an early stage of dismantling then people are carried to the ship in a basket which is attached to a crane. Figure 7 shows how workers are transported to the ship during the observations

Figure 7: Workers are being transported on to ship

2.3 (b) Cutting On-board (Deck)

There were three workers on board the ship and each had an assistant to help the cutting process and also to minimize careless accidents. There was also a foreman managing the work being done on board. Cutting on board for the L shaped panel, is performed by two workers. (A ship cutter and his assistant) as shown in Figure 8.

Figure 8: Cutting on board

2.3 (c) Transporting the block to shore

After the cutting process is finished, the L shaped block is attached to a mobile crane working on shore next to the ship. The crane is a Link-Belt crane with a lifting capacity of 130 tons. Figure 9 shows the L shaped block being removed from the ship. For this procedure there is an operator manning the crane and a foreman on board directing him with signs.

Figure 9: Crane, transporting block from ship to shore.

2.3 (d) Transport to Secondary Dismantling Zone

Once the block is carried to the shore then the crane operator rotates the block to make it ready for loading onto the truck. With this particular task, the crane operator and another extra worker is involved in assisting in the rotating of the block. After the crane loads the block onto a truck, the truck transports the block to the secondary dismantling zone. Only the truck driver is involved in the task of transporting the block to the secondary dismantling zone. Figure 10 shows the block being transferred to secondary dismantling zone.

Figure 10: Transport to secondary dismantling zone

2.3 (e) Cutting in Secondary Zone

Cutting in the secondary zone involves cutting the block or panel into smaller pieces which is a technical requirement by the smelter. One worker is tasked with cutting the L shaped panel. Figure 11 shows cutting in secondary zone.

Figure 11: Cutting in secondary dismantling zone

2.3 (f) Loading cut pieces to trucks

After cutting the panel into the required dimensioned pieces, a poly-grab machine collects the cut pieces and loads them onto a truck. One worker has the task of operating the poly-grab and another is tasked with the transportation of the cut pieces to an external site. Figure 12 shows the polygraph in operation

Figure 12: Poly-grab collecting cut pieces

3. SAFETY WORKSHOP

In order to discuss the observations made during the field study a safety workshop was arranged in the UK involving 4 HSE experts, 3 shipyard employees and 3 members from academia. It is clear to see that a wide range of experts with knowledge on shipbuilding manufacturing processes, risk assessment and HSE related topics were assembled.

During the meeting each stage of aforementioned dismantling procedure is handled separately and safety gaps in each stage is identified by the safety experts.

3.1 ACCESS OF WORKERS ON TO SHIP

Two workers from the ship breaking yard were transferred from the ground to the ship's deck by a crane with a basket. Safety gaps highlighted by the experts during the workshop are presented in Table 6.

Table 6: Safety gaps

Hazard Identification	Mitigation
Stage 1: Access of workers on-board ship	
No Safety Harness	Better training
No Load Testing (already exists)	Colour Coded 'tag in system' to allow for clear visibility to whether the equipment has been tested
Not Adequate Gate on basket	Needs to be lockable gate

3.2 CUTTING ON-BOARD

This stage involves the cutting of the ships' structure in an L shape panel section (side/deck) using oxy-acetylene cutting. Safety experts identified potential safety gaps which are shown in Table 7.

Table 7: Safety gaps

Hazard Identification	Mitigation
Stage 2: Onboard cutting	
No safety rails	add staging and harness
Slip, trip, fall- welding particles with water	Good housekeeping training
Burn hose	training
No entry management in zone surrounding work	signage warning boards
No mask to prevent fume inhalation	provide and enforce PPE usage
Wearing short sleeved T-shirt	wear protective boiler suit
No ear plugs	provide and enforce PPE usage
Man standing on beam (n/a)	-
welding burr going into water	Use a boom or bucket system
System of work (cutting procedure)	Cut inside first then top last?

3.3 TRANSPORT TO SECONDARY DISMANTLING ZONE

This stage involves lifting the previously cut steel structure from the vessel by a crane to a truck and then driven and dumped by the truck in the secondary zone. The views of safety experts are shown in Table 8.

Table 8: Safety gaps

Hazard Identification	Mitigation
Stage 3: Transporting Steel Structure	
Lifting Method of open hooks and one hole	Use 2 holes with closable hooks
No load testing (already exists)	Colour Coded 'tag in system' to allow for clear visibility to whether the equipment has been tested
loose pipe	-
Structure Swinging around	Use control ropes
No specified 'Drop zones'	Use clearly signed roped off areas as drop zones
No lashings on truck	use lashings to prevent structure from bouncing off
No truck marshal	use truck marshal to safely guide truck to secondary cutting area

Other Remarks: Travelling speeds for trucks suggested = 5-10mph

3.4 CUTTING IN SECONDARY ZONE

The steel structure is then systematically cut up in to 0.5m x 0.5m pieces and safety gaps identified during this procedure are as shown in Table 9.

Table 9:Safety gaps

Hazard Identification	Mitigation
Stage 4: Cutting up Steel Structure	
Smoke fumes coming from other worker	have better zone management
Plate placed on other steel plate at an angle	-
Trip hazards	-
Cable Hazards	-
Noise	provide and enforce PPE usage

4. DISCUSSIONS & CONCLUSIONS

In comparison with other ship dismantling countries, Aliaga/Turkey can be introduced as a successful example in demonstrating acceptable levels of HSE management. However when compared with the ship dismantling yards in India, Pakistan, Bangladesh and China, (steel prices per tonne) Turkish ship dismantlers pay lower to ship owners than the other countries. This originates from several different reasons. Some are listed below.

- Re-saleable items are limited with some machinery pieces. There is not significant demand for any second hand materials in respect to machinery and other practical consumables. Commonly yards are donating these second hand items to charities.
- Amount of waste on board ships means more cost to shipyards in Turkey because yards are paying money to the waste disposal institutes.
- The administrative burden of laws and regulations on HSE is increasing the workload of yards. The slow flow of documentation between government and dismantling yards has even lead to the dismantling of ships being placed on hold.
- Labour costs are higher in Turkey when compared to other ship dismantling countries mentioned above. Workers, who have all the social rights, are covered with insurance. Any hazard to human health causes yards to pay big compensations.
- Yards only dismantle the ships, then they sell the scrap to smelters, which mean additional transportation cost.

As a result it has never been possible for Turkey to compete with the steel prices which other Far Eastern ship dismantling countries pay. Therefore it has always been difficult to make ship-owners interested in dismantling their vessels in Turkey. However the new IMO convention is making ship-owners responsible for dismantling their ships in ship dismantling yards which meet the level of HSE precautions required during the dismantling of ship. New rules are likely to affect the current ship dismantling practices all over the world.

Like any other professional business, the ship dismantling business will survive as long as it is still profitable. Making sure that HSE is protected is mandatory but in reality a good and careful optimisation is necessary in between protecting HSE

and its cost to the business. After all the safety gaps are identified there needs to be a value analysis to be carried out in order to see how much it will cost to the company, as it is necessary for sustainability of the business.

The results of the safety workshop displayed in this paper clearly show that in each aforementioned stages of ship dismantling, the safety experts point out safety gaps that can be enhanced with better training and management. Applying all these safety measures to the Aliaga ship dismantling yards is definitely useful, and it is necessary to carry out cost-benefit analysis. In that case is it acceptable to neglect the HSE? The answer is clearly no.

Although safety experts pointed out some safety gaps in the processes, the amount of accidents in Aliaga is really low when compared to other major ship dismantling competitors. Furthermore, in recent years in Turkey the surprising fact is that accident rates and fatalities in ship dismantling are lower than in the ship building industry. SRAT's role on this low accident rate cannot be neglected. No more than 10 years ago ship dismantling was experiencing the same problems in terms of fatalities and accidents, and according to safety workshop, explained in previous section, there are still safety gaps (in comparison to the best practice for ship dismantling). However, it is important to search the reason for low number of accidents then.

The main reason for this success is definitely the worker profile. The average experience of a worker in Aliaga is 19 years. In any business the more experienced the worker is the higher quality work is expected from him. Humans are at the centre of any dismantling work being done in Aliaga. The advantage of having experienced workers is undoubtedly leading to less accidents.

On the other hand the better management of human factors is of vital importance. SRAT is responsible for training all Aliaga workers. Periodic training on HSE is being given to the workers. "*Before developing training, it is vital to understand the capabilities of your workers"* mentions the training manager of Aliaga, and adds *"here, instead of saying people there is PCB in oil we ask them not to touch the oil and explain the possible consequences if they do so*" (SRAT has a special waste removal group which has adequate training and equipment to do the required job). Similar to the training manager's statement, Stranks [5] mentions;

"Successful management of human factors and the control of risk involve the development of systems of work designed to take account of human capabilities and fallibilities."

Each business is unique therefore the problems in that business can only be solved by a good understanding of the procedures and the origins of the problem in those procedures. In other words process based approach to each problem will lead to quick and effective solutions. For example in Aliaga, most of the accidents and fatalities were occurring on board ship therefore they deployed an assistant for each ship cutter who is just helping the cutter, holding the hose or helping to prevent slips and traps. Moreover the ship cutters are the most experienced cutters in the ship dismantling yards. The assistants are not only helping the ship cutters but also learning the job from them.

To make sure that the work being done is safe, each group of workers is lead by a foreman. The foreman is continuously watching the workers and making sure the work being done is safe.

According to a report prepared by Ministry of Labour and Social Security [6]; Many accidents were originating from handling heavy objects and in the past heavy objects have been carried by manual workforce, now all transport, loading and unloading are automated therefore accidents due to handling heavy objects has dramatically decreased.
Apart from all of the above SRAT is auditing each dismantling yard, and checking all HSE concerns.

ILO [7] states;

"The process of improving working conditions at a shipbreaking facility must be approached systematically in order to bring these up to reasonable standards".
Improvements in recent years in Aliaga shows a good application of the ILO's statement. Moreover in Aliaga the good practice of managing the human element is leading to safer working conditions. The ways of dealing with problems in Aliaga are good examples of basic human factor solutions. The

effectiveness of these solutions is really encouraging for further developments. Making ship dismantling procedures human centred, developing new procedures to improve human performance and to decrease the health hazards will lead to safer and more productive work practices. Creating process based smart training for workers will enhance the performance of humans who are the key elements in all ship dismantling procedures.

As a result the usefulness of the application of best practice is not arguable; however companies are financially not capable of meeting the ship building yards' standards. Therefore the best way of dealing with the problem will be through enhancing worker performance and awareness.

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